Amended claim 1 recites a color display optical system having a refractive lens array for receiving and focusing diverging color components of light and a holographic grating receiving the color components of light from the refractive lens array for aligning the color components of light along distinct, non-diverging paths. An imaging device has an array of pixels with pixel apertures with which the holographic grating aligns the color components of light along distinct, non-diverging paths. Applicant submits that claim 1 is patentably distinct from the cited reference for the following reasons.

Nakanishi describes a projection type image display apparatus with holographic elements positioned after a liquid crystal display element (Figs. 1, 2, 6, 7), or before a microlens array (Figs. 8, 9, 14, 15, 18, 21), or both (Figs. 13A, 13B). Nakanishi describes these arrangements as reducing the aperture required by the projection lens, and thereby reducing the cost of the system:

> As a result, diverged light, which cannot be conventionally used without a projection lens with a large aperture, can enter a projection lens having a comparatively small aperture. This results in a compact and light display apparatus as well as a low production cost of the projection lens. Nakanishi, col. 8, lines 56-61.

These purported benefits are explained with reference to the disadvantages described in prior projection displays.

> In order to project all the beams exiting from the liquid crystal display element on the screen, it is necessary to use a projection lens having a large aperture (i.e., having a small F-number) as that shown in FIG. 23B as a larger circle. However, a projection lens with a smaller F-number is more difficult to produce, which is one of the reasons for the high production cost. Nakanishi, col. 3, lines 12-18.

In contrast to positioning holographic elements after a liquid crystal display element or before a microlens array as described in Nakanishi, amended claim 1 recites a holographic grating positioned between a refractive lens array and an imaging device. As described in the application, this arrangement functions to counter-diverge the color channels so that the average angle for all three channels (i.e. R, G and B) exiting the microlens array is made to be substantially normal to the imaging plane of the imaging device. In one implementation this

provides a telecentric configuration in which the pixel apertures of the imaging device (e.g., LCD or DMD) are located at the front focus, resulting in the chief rays being parallel to the optical axis in the image space (i.e., normal to the plane of imaging device).

Applicant submits that Nakanishi provides no teaching or suggestion of positioning a holographic grating between a microlens array and an imaging device, as recited in claim 1. Nakanishi is directed to reducing aperture size of the projection optics and so is directed to positioning holographic elements before the microlens array or after the LCD. Nakanishi et al. discloses no structure or arrangement positioned between the microlens array and the imaging device to counter-diverge the color channels exiting the microlens. Instead, Nakanishi is directed to reducing the projection lens aperture rather than providing parallel chief rays at the pixel apertures. Applicant requests, therefore, that claim 1 be allowed.

Applicant submits that claims 2 and 4-11 are patentable as being dependent on patentably distinct claim 1. Claim 3 has been cancelled for consistency with amended claim 1. Applicant believes dependent claims are further patentable for the following reasons.

Amended claim 2 recites that the imaging device defines a plane and the holographic grating aligns the distinct color components of light to be normal to the plane. This clarifies that the recited plane corresponds to an imaging device (e.g., an LCD or a DMD) rather than passive projection display screen 40 shown in Fig. 8 of Nakanishi. Applicant submits that Nakanishi provides no teaching or suggestion of a holographic grating positioned between a microlens array and an imaging device to align distinct color components of light to be normal to the plane of the imaging device. Applicant requests, therefore, that the rejection of claim 2 be withdrawn.

Claim 4 recites that the lens array includes an array of cylindrical lenses. The Examiner cites Fig. 7 of Nakanishi as showing an array of cylindrical lenses in cross section. Applicant submits that such an interpretation of Fig. 7 is not

supported by, and is inconsistent with, the description of microlens arrays in Nakanishi. Nakanishi states with reference to Fig. 22 that that the pitch of the microlenses of the microlens array 107 corresponds to the pitch of groups of three pixels for R, G and B of the liquid crystal display element 108. Col. 2, lines 40-42. Fig. 22 is analogous to Fig. 7, and there is no teaching or suggestion of a pixel arrangement differing from a conventional interdigitated pixel arrangement for which a conventional two-dimensional array of spherical microlenses would be used. Applicant submits, therefore, that the rejection of claim 4 is improperly based upon an unsupported interpretation of the reference. Applicant requests that the rejection of claim 4 be withdrawn.

With regard to claim 5 the Examiner states that "optical power refers exclusively to refractive, as opposed to diffractive, effects." The claim is apparently rejected because the holographic elements of Nakanishi must therefore not have optical power. Applicant notes, however, that optical power may be imparted refractively, reflectively, and diffractively. Curved mirrors are commonly used to impart optical power, as in telescopes. The commonality of diffractive optical power is supported simply a search of the Patent Office database, which returns 338 patents as using the term "holographic lens." Applicant submits, therefore, that optical power can be imparted diffractively and that Nakanishi provides no teach or suggestion of a holographic grating "without optical power." Applicant requests, therefore, that the rejection of claim 5 be withdrawn.

Amended independent claim 12 recites an optical system having a focusing element for focusing separated color components of light to plural distinct regions of an imaging plane. A diffractive color dispersing layer is positioned between the focusing element and the imaging plane for aligning the color components of light along distinct, non-diverging paths, the imaging plane including an array of pixel apertures of an electronic imaging device. Applicant submits that claim 12 is patentably distinct from Nakanishi for the following reasons.

Amended claim 12 recites that the imaging plane corresponds to an array of pixel apertures of an electronic imaging device. In addition, amended claim 12 clarifies that the diffractive color dispersing layer is positioned between the imaging plane and a focusing element that focuses color components onto the image plane. Nakanishi does not teach or suggest such an arrangement in Fig. 7, or any other figure.

In particular, Nakanishi does not teach or suggest a diffractive color dispersing layer that receives light from a focusing element (e.g., a microlens array) and aligns the color components as they propagate toward an electronic imaging device. Fig. 7 of Nakanishi shows a holographic element that directs light after it has passed through a LCD. In other figures Nakanishi shows a holographic element positioned before a microlens array. Accordingly, applicant submits that claim 12 is patentably distinct from the cited reference and request that the rejection of claim 12 be withdrawn.

Applicant submits that claims 13-19 are patentable as being dependent on patentably distinct claim 12. Applicant believes dependent claims 4 and 17 are further patentable for the reasons set forth above with reference to Figs. 4 and 5.

Amended claim 20 includes subject analogous to that of claim 21, which has been cancelled. Claim 21 recites a telecentric color filtering method for providing telecentric color-filtered light to an imaging plane of an electronic imaging device. The method includes forming plural diverging color light components, directing the plural diverging color light components through a focusing element positioned before a holographic grating, and directing the plural diverging color light components through the holographic grating to align the color light components along distinct, non-diverging paths that are telecentric with respect to the imaging plane. Applicant submits that claim 20 is patentably distinct from the cited reference for the following reasons.

Nakanishi describes a projection type image display apparatus with holographic elements positioned after a liquid crystal display element (Figs. 1, 2, 6, 7), or before a microlens array (Figs. 8, 9, 14, 15, 18, 21), or both (Figs. 13A,

13B). In contrast to a system with holographic elements positioned after a liquid crystal display element or before a microlens array as described in Nakanishi, amended claim 20 recites a filtering method in which a holographic grating is positioned between a refractive lens array and an imaging device.

Applicant submits that Nakanishi provides no teaching or suggestion of a filtering method that employs the sequence of optical steps recited in claim 20. Nakanishi is directed to reducing aperture size of the projection optics and so is directed to positioning holographic elements before the microlens array or after the LCD. Nakanishi et al. discloses no structure or arrangement positioned between the microlens array and the imaging device to counter-diverge the color channels exiting the microlens. Instead, Nakanishi is directed to reducing the projection lens aperture rather than providing parallel chief rays at the pixel apertures. Applicant requests, therefore, that claim 20 be allowed.

Applicant submits that claims 22-24 are patentable as being dependent on patentably distinct claim 20. Applicant believes dependent claims are further patentable for the following reasons.

Applicant believes the application is in condition for allowance and respectfully requests the same.

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Attachment
Claims 1, 2, 4-20, and 22-24
Application Number: 09/681,185

1. (Amended) A color [filter] display optical system, comprising:

a refractive lens array for receiving and focusing diverging color components of light; [and]

a holographic grating receiving the color components of light from the refractive lens array for aligning the color components of light along distinct, non-diverging paths; and

an imaging device having an array of pixels with pixel apertures with which the holographic grating aligns the color components of light along distinct, non-diverging paths.

2. (Amended) The [filter] system of claim 1 in which the imaging device defines a plane and the holographic grating aligns the distinct color components of light to be normal to [a selected] the plane.

4. (Amended) The [filter] system of claim 1 in which the lens array includes an array of cylindrical lenses.

5. (Amended) The [filter] system of claim 1 in which the holographic grating is continuous and without optical power.

6. (Amended) The [filter] system of claim 1 in which the holographic grating includes a volume hologram.

7. (Amended) The [filter] system of claim 1 further comprising a color divergence element that provides the diverging color components of light to the refractive lens array.

8. (Amended) The [filter] system of claim 7 in which the color divergence element includes plural angularly inclined dichroic mirrors for providing color separation of incident multi-color illumination light.

9. (Amended) The [filter] <u>system</u> of claim 7 in which the color divergence element includes a holographic grating for providing color separation of incident multi-color illumination light.

10. (Amended) The [filter] <u>system</u> of claim 9 in which the holographic grating of the color divergence element is substantially the same as the holographic grating for aligning the color components of light.

11. (Amended) The [filter] <u>system</u> of claim 1 in which the holographic grating delivers the distinct color components of light to a selected plane and is positioned substantially midway between the selected plane and the lens array.

12. (Amended) In an optical system having a focusing element for [delivering] <u>focusing</u> separated color components of light to plural distinct regions of an imaging plane, the improvement comprising:

a diffractive color dispersing layer positioned between the focusing element and the imaging plane for aligning the color components of light along distinct, non-diverging paths<u>, the imaging plane including an array of pixel apertures of an electronic imaging device</u>.

13. The system of claim 12 in which the focusing element includes a microlens array.

14. The system of claim 13 in which the microlens array includes plural cylindrical lenses.

15. The system of claim 12 in which the diffractive color dispersing layer aligns the color components of light to be normal to the imaging plane.

16. The system of claim 12 in which the diffractive color dispersing layer includes a volumetric hologram.

17. The system of claim 16 in which the diffractive color dispersing layer is isotropic and without optical power.

18. The system of claim 12 in which the imaging plane is a transmissive type electronic display panel with pixel apertures in a stripe formation.